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(Tl, Au)/Si(111) and (Tl, Au)/Si(100) 2D compounds: Atomic and electronic structure and transport properties

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Discovery of graphene has stimulated the current interest to atomically thin, two-dimensional (2D) materials which might exhibit unique properties not observed in the bulk materials. Metal-induced surface reconstructions on silicon and germanium (i.e., metal films of a monolayer or submonolayer thickness on silicon or germanium) are vivid examples. Most of the studies in this field have been restricted to reconstructions built of a single atomic species. Natural expansion of the research area is the exploration of the 2D multi-component systems.

Formation of the highly-ordered $\sqrt{7}\times\sqrt{7}$-periodicity 2D compound has been detected in the (Tl, Au)/Si(111) system as a result of Au deposition onto the Tl/Si(111) surface and its composition, structure and electronic properties have been characterized using scanning tunneling microscopy (STM), angle-resolved photoelectron spectroscopy (ARPES) observations and density-functional-theory (DFT) calculations. On the basis of these data, the structural model of the Tl-Au compound has been proposed, which adopts 12 Tl atoms and 10 Au atoms (in total, 22 atoms) per $\sqrt{7}\times\sqrt{7}$ unit cell, i.e. ~1.71 ML of Tl and ~1.43 ML of Au (in total, ~3.14 ML). Qualitatively, the model can be visualized as consisting of truncated-pyramid-like Au clusters with a Tl atom on top, while the other Tl atoms form a double layer around the Au clusters.

On the Si(100) formation of the highly-ordered $\sqrt{2}\times\sqrt{2}$-periodicity 2D compound has been detected and its composition, structure and electronic properties have been characterized using STM, ARPES spectroscopy observations and DFT calculations. The structural model of this Tl-Au compound on the Si(100) surface is much simply than that on the Si(111) one. It adopts 2 Tl atoms and 2 Au atoms per $\sqrt{2}\times\sqrt{2}$ unit cell, i.e. 1.0 ML of Tl and 1.0 ML of Au (in total, 2.0 ML).

Both (Tl, Au)/Si(111)$\sqrt{7}\times\sqrt{7}$ and (Tl, Au)/Si(100)$\sqrt{2}\times\sqrt{2}$ compound has been found to exhibit pronounced metallic properties at least down to the temperatures as low as ~2 K. Low-temperature magnetotransport properties will be discussed in the talk.